NPIC/D-77/70

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MEMORANDUM FOR: Assistant Deputy Director for Intelligence

SUBJECT : Proposed Contract with [redacted] to Develop Optical Image Manipulation Techniques at a Cost of [redacted]

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1. This memorandum requests approval for the commitment of funds for a contract. The specific request is stated in paragraph 7.

2. a. The contract proposal is concerned with the problem of increasing the amount of information extracted from degraded photographic images. Primary emphasis is placed on developing the in-house staff expertise necessary to execute the manipulations involved, to calibrate the specialized optical system required, and to extend the knowledge gained to related problems.

b. Experience has shown that to some extent on each mission, the interpretability of important operational imagery is degraded by errors in camera focus, image motion compensation, exposure, and other system malfunctions. There is no exact measure of how often errors occur, but it is known that there is not always an opportunity to reshoot the target. Similar problems are encountered with attache and clandestine photography. The only techniques currently available to improve degraded images are the limited variations in developing and printing that can be performed by the photographic laboratory. Experience has demonstrated that most of the degradations present in the sophisticated NPIC imagery do not respond to these classical remedies. In theory two alternatives have been available for many years - one employing digital computers to perform the corrective manipulations, the other using a coherent optical system. Both are complex and expensive and until recently amounted to little more than laboratory curiosities. With the advent of special rapid data processing algorithms, called Cooley-Tukey transforms, the computer approach has been advanced to the point where photographic imagery can be investigated in depth. With a similar impact, the introduction of a practical laser light source overcame the major limitation of the coherent optical system. These advances in the state-of-the-technology stimulated research in both areas.

c. Since the theory and mathematics of image manipulation can be applied to either technique, each was a potential laboratory model for applied research. The optical system performed manipulations at the speed

SUBJECT: Proposed Contract with [redacted] 25X1
to Develop Optical Image Manipulation Techniques at a Cost
25X1 of [redacted]

of light; however, this proved to be a disadvantage. Like a football coach with slow motion instant replay TV, the scientist needs to examine his model directly at selected stages of execution; the optical system is too fast. Fortunately, the digital computer provides the necessary flexibility and the basic image manipulation research has been performed with this tool. As a result, the general validity of the theory has been demonstrated experimentally.

d. In the operational environment a hybrid system will be necessary. Fast manipulations on relatively large image areas will be performed optically. When the target of interest involves minute detail, nonlinear corrections, and maximum accuracy, the digital techniques will be employed. The necessary digital research is already underway; requirements for the optical portion are set forth below.

3. a. The proposed contract would provide the direct theoretical and laboratory support necessary to develop and apply Optical Image Manipulation (OIM) techniques to operational material in an in-house facility. The project is planned for execution in three overlapping phases conducted during a one year period. The first phase would involve development of basic expertise and optical calibration. The contractor would conduct two 3-5 day laboratory sessions per month in [redacted] for 2 optical engineers and one technician. Each session would ~~discuss~~ the theory, design and perform the experiment, evaluate the results, and plan ~~for~~ the experiments to be performed before the next session. In the second phase the contractor would participate in the operational imagery experiments and develop the theoretical data necessary to determine viewing system specifications in the final phase. 25X1

b. The proposed project would also provide essential knowledge and advance the level of technology in several related areas which require the same basic optical components and staff expertise as OIM. For example, the characteristics of the viewing system used in examining the manipulated ~~changes~~ images would be determined in a variety of configurations, while making sure that the viewing system itself does not degrade the image. In another application, the coherent optical system will serve as a tool in the study of image non-linearities such as those inherent in dual gamma processing and color film images. The effect of these distortions must be determined before duplication standards can be established. Other topics

SUBJECT: Proposed Contract with [redacted] 25X1
to Develop Optical Image Manipulation Techniques at a Cost
25X1 of $[redacted]

include extension of the power spectral density work to color film originals and the development of special holographic filters for improving degraded images of written material. The latter topic is of particular interest to TSD/DDP, consequently, coordination has been affected with
25X1 [redacted] of that office.

d. The concepts to be used in this project are well established theoretically. Experimental work has demonstrated that some improvement, estimated subjectively, can be expected. The significance of the improvement, in terms of improved information extraction with large area operational imagery has yet to be determined. While there is no guarantee of success, the risk is judged to be small ~~of what~~ in view of the digital results to date and the demonstrated expertise of the proposed contractor.

e. The deliverable items will consist of $2\frac{1}{2}$ man-years of scientific and technical support, a handbook of experimental and theoretical details necessary to employ Optical Image Manipulation Techniques, and preliminary design specifications for optical viewing systems.

25X1 4. [redacted] has exceptionally well qualified personnel for this project. Their unsolicited proposal includes a proprietary theory for utilizing optical image manipulation to optimize information extraction from imagery. Accordingly, no other proposals have been considered.

5. Follow-on action at approximately the same level of effort is anticipated and would consist of a similar but more advanced, applications oriented program, with major emphasis on optical-digital hybrid system characteristics. Specific projects resulting from this effort will be funded as separate R&D items and will not necessarily be with
25X1 [redacted]

25X1 6. The [redacted] is appropriate; the Project Officer will assign security classifications to the individual reports.